Neural Networks – Is powerful than human brain?

Introduction

Humans always look forward for inventions or discoveries because of their discontented curiosity and aspiration. It is the human brain that makes those inventions possible became the model for a novel field called artificial neural networks (ANN) commonly referred as neural networks. Fascinated by the term "neural networks", I set out to do some research on that. Some researches pose the neural networks as a biological model, emulating the functionality of biological neurons while some associate that to artificial intelligence (AI). The questions that arose in my mind were: How is this Neural Networks different from other computational models? Is that really a beneficial tool for real-life applications? Does it perform better than human brain?. In the following sections I try to find answers to my questions by identifying the biological roots of the field as well as the relation to artificial intelligent systems.

Historical Development

During 1940's Warren McCulloh and Walter Pitts proposed a model called neural networks. The model was based on the innovative contemporary work namely "information theory" by Claude Shannon, Alan Turing and others. In the late 1950's Frank Rosenblatt proposed an early ANN model called "Perceptron". It is a pattern classification system that was primarily designed as a computational model for the retina of the eye. But there was a setback in the field due to the book "perceptrons" published by Minsky and Papert, which identified several limitations of the model. In early 1960's Bernard Widrow and Ted Hoff invented a system called Adaline (Adaptive linear element) a neural network that adapts a system to minimize the

error signal using supervised learning. Inspite of the setbacks, during early 1980's the field entered a period of explosive growth.

Different perspectives

There are different perspectives when viewing and analyzing neural networks. Some researchers perceive neural networks as dynamic systems that can be used in real time applications such as the computational models for business and commercial purposes. While some of them view neural networks as a means for implementing a variety of cognitive and sub-cognitive mechanisms, operating over a wide range of domains. The domains include vision processing, speech production and pattern recognition. In recent years, ANN is identified as an information processing system that has certain performance characteristics common with biological neural networks. "It can emulate the biological networks in that they do not require the programming of tasks but generalize and learn from experience"[1]. ANN is also referred as connectionist systems since that involves interneuron connections and the study of this approach is called as connectionism.

Definition

Although there are diverse approaches for neural networks, the following definition aptly defines the ANNs.

"ANNs may be defined as structures comprised of densely interconnected adaptive simple processing elements (called artificial neurons or nodes) that are capable of performing massively parallel computations for data processing and knowledge representation" [2] .

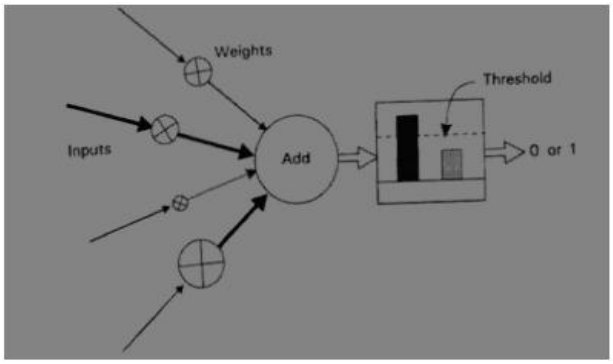
There is a close analogy between a biological neuron and an artificial neuron and their corresponding network mechanisms. The following table illustrates this analogy.

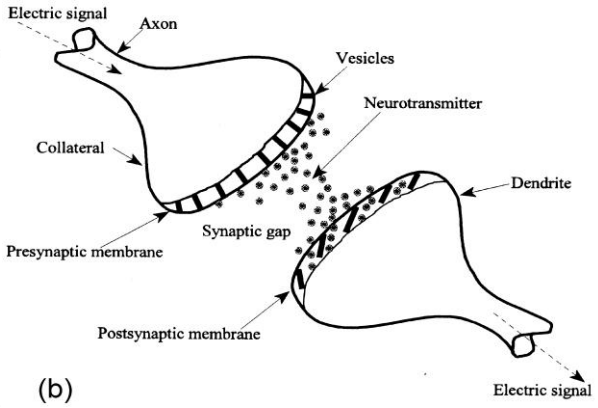
Analogy between a biological Network and artificial Network

Biological Network	**Artificial Network**
Neuron – Nerve cell	Artificial Neuron - Nodes or units
Synapses – Interneuron connections mediated at electronic junctions	Connection Weights
Axon : Branching fiber from soma Dendrite : Input fiber to soma	Connections between the units or nodes
Soma – Cell body, that sums the incoming signals	Threshold Logic Unit (TLU) that sums the weighted signals

[7] (a) Artificial Neuron and (b) Biological Neuron

(a)





In Biological network, if the resulting signals in soma exceed some threshold then the neuron will "fire" or generate a voltage response which gives an impulse which is then transmitted to other neurons via axon. In artificial network, the threshold logic unit (TLU) compares the sum of

the weighted signals with the threshold value. If the signals or activation exceeds the threshold value then the unit output the value 1 otherwise outputs 0[5].

Classification of ANN's

A neural network is characterized by (1) its pattern of connections between the neurons (called its architecture) , (2) its method of determining the weights on the connections (called its training or learning rule or algorithm), and (3) its activation function (or activity level) which is a function of the inputs it has received.[4]

Features of ANN's that differentiates it from AI

The field of Artificial intelligence aims at two purposes. First, the purpose is to augment human thinking with the help of intelligent systems. Second, the purpose is to develop systems that understand human thinking. The neural networks were designed as storage information systems that memorize the images or results just like the human brain. There are four features that differentiate ANN's from conventional computational models or artificial intelligent systems. They are:

(i) ANN's learn by example (i.e. they memorize): utilize data from earlier examples to produce output.

(ii) Constitute a distributed, associative memory: Distribute meaning that the information is spread among all of the weights (memory units) that have been adjusted in the training process. Associative in the sense if the trained network is presented with partial input the network will generate an output that corresponds to a full input by finding closest match to that in the memory.

(iii) fault-tolerant : Since the information is distributed throughout the network, even when a large number of weights are destroyed, the system does not fail catastrophically and

(iv) capable of pattern recognition : match large amounts of input information and produce generalized output for an incomplete data[3].

Neural networks in Real Life applications

Diverse fields deploy neural networks to enhance the products, marketing techniques and consumer usability. The following are examples:

Biomedical:

In mid 1980's Anderson et al. developed an auto associative neural network that store a large number of medical records each of which includes information on symptoms, diagnosis and treatment of a particular case. On feeding the symptoms as inputs, the network correctly produced the diagnosis and treatment as output. In an another instance the pap smear systems called Papnet was able to detect cancerous cells that was unidentified by other technologies.

Detecting Fraudulent transactions

Several people are affected by credit card theft each year which is a major threat to the society. Since ANN is a pattern storage and recognition system that monitors a pattern and causes activation of a node, they are used by credit card companies such as American Express, First USA and others to study patterns of credit card usage and to detect transactions that are potentially fraudulent.[6]

Speech Recognition

Several types of neural networks have been used for speech recognition. Phonetic type-writer is a neural network developed by Kohonen using the self-organizing map. The input is based on short segments of the speech waveform. If the network identifies similar inputs, different examples of the same phoneme occur close together in the output unit. The output units can also be connected to the appropriate typewriter key to construct phonetic typewriter.

In addition, neural networks are also used in petroleum exploration, financial forecasting, real estate analysis, optimizing marketing strategy, quality control programs and airline seating allocation systems.

Discussion and Conclusion

After analyzing the usefulness and limitations of neural networks, I am led to believe that neural networks only partially emulate a human brain. Although neural networks learn things by memorizing, they also recognize the patterns by matching images stored in the memory, similar to human brain; however they differ from human brain in many aspects. ANN can be compared to an amateur employee entering a new job. The employee learns his/her job by practice, acquire skills and become an expert. Similarly from its inception, ANN does not know anything about the job it's going to perform, it only learns by training and pattern recognition; therefore become an expert. Scientists say learning new things stimulate dendrite connections between neurons and the brain stay healthy in recalling things. But the human memory is volatile it is certainly prone to amnesia due to several factors such as aging and illness. Also the accuracy and speed of the neural networks definitely outwit the human brain in performing the tasks such as mathematical

calculations since we all know computational models or even simple calculator computes things faster and accurate than human brain. But to answer the key question: Is neural networks powerful than human brain. I prefer to say no because of the following reasons: Human brains are better at decision making process when it sees a task for the first time. Consider an instance of the Anderson model of the neural network in detecting diagnosis and treatment of the disease in which symptoms are fed as inputs. The network will try to find a closest match in reviewing the previous record, but what if there is no previous record exist for that symptom, Can the net produce some output? On the other hand if a doctor is performing this task he/she will try to understand about the current circumstances , communicate with colleagues and use his/her previous knowledge to provide a treatment to the patient. But this task cannot be performed by an ANN since updates are not immediately possible in the systems, only by training they acquire the skills. Secondly every neural network performs some task individually; no generalized rules apply for all designs of ANN. A human brain can portray a person with different capabilities such as to act as a researcher, driver, writer and decision-maker. But all these tasks cannot be performed by a single ANN. Although discrete ANN's can perform these tasks shrewdly, training them to make an expert or a decision maker in all cases is difficult and no such systems have been invented yet. In addition, neural networks may be intelligent but they may not be creative like the human brain. Creativity is a unique feature blessed to human brain by the great Creator of universe and no other artificial devices can be designed to emulate that behavior.

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